TITLE OF THE INVENTION

LIGHT-WEIGHT METAL CASTING OF GOLF CLUBS

BACKGROUND OF THE INVENTION

This invention relates to the technology of metal casting and particular to the technology of casting golf club heads, components, and clubs.

BRIEF SUMMARY OF THE INVENTION

This present invention is a method and means of casting state-of-the-art golf club parts out of magnesium and other light-weight metals by applying existing squeeze-casting or metal injection molding (MIM) technology to the unique problems of golf club manufacture. Metals that have been used to cast golf club components can also be squeeze cast or made by MIM. Such metals include aluminum, titanium, and magnesium.

Squeeze casting of aluminum golf club parts has already been accomplished. The present invention applies squeeze casting and

MIM technology to light weight metals such as magnesium and titanium. The squeeze-cast golf club parts, primarily heads, can then be machined and assembled together.

The weight of golf club heads can be significantly reduced by using squeeze cast or MIM casting for head components. The weight savings can provide room for specialized weighting of the golf club head to accomplish various design and performance goals.

OBJECTS AND SUMMARY OF THE INVENTION

Squeeze casting, or semi-solid casting, is a process of melting the subject metal alloy, pouring it into a half-open vertical mold/die, allowing it to become semi-solid, and then applying the top half of the die with pressure during the solidification process. The cast is made with less pressure than required for ordinary forging and produces a product that is less porous and mechanically stronger.

Parts possessing greater detail and incapable of being forged can be cast by these methods, reducing machining and improving strength of the detail sections. Automobile parts requiring high-quality metal construction, particularly safety features such as brakes and steering components, are now made by squeeze casting.

Squeeze-cast parts are more easily heat-treated and can be more readily welded, due to their low porosity. This means that unique golf club head properties such as strong bodies and hard face plates and sole plates can be accomplished by squeeze-casting or MIM casting. MIM parts can be produced from ferrous and non-ferrous metals and alloys.

The method proposed is that components be squeeze cast or MIM cast out of separate magnesium or other metal alloys and treated separately, such as heat-treating face and sole plates to heat them for hardness. The cast parts need less machining because of the qualities of the cast metal, reducing unique golf club

production costs. Finally, components can be welded, screwed or glued together more successfully due to the higher-quality, low porosity cast metal parts.

As a separate goal, this invention uses squeeze casting to produce hollow golf club heads with minimal weight combined with maximum strength, so that custom weighting of the head can be performed. All of the light weight metal golf club head components can be squeeze cast, including titanium sole plates and face plates.

As an additional goal, this invention allows the manufacturer to control the thickness of the metal in the walls of the club head and thereby control the weight.

DETAILED SPECIFICATION

Pursuant to this invention, precision castings of golf club components, such as putter heads and driver heads, sole, and face plates, can be achieved. Cast metal golf club parts that have complex inner geometries or require high-quality finishes can be

produced without expensive machining. Light-weight metals such as aluminum, titanium, and magnesium alloys can be successfully cast in this manner, as well as various steel alloys.

The steps involved in applying squeeze casting to golf club manufacture involve 1) designing a mold or molds for the golf club parts, taking advantage of the unique properties of squeeze-casting to produce high-quality, light-weight metal parts, 2) selecting the appropriate alloy to be cast, based on intended strength, weight, and hardness of the part, 3) pre-heating the mold to receive the metal to be cast, 4) pouring a semi-solid mass of the alloy selected in 2) into the mold, 5) using the ram of the squeeze-casting machine to push the semi-solid metal into the mold with a pressure determined by the selection of metal and the tensile qualities desired in the part, 6) removing the finished part from the mold and performing subsequent trimming and finishing work.

The MIM process begins with the atomization of molten metal to form metal powders. Then, the metal powder is sieved followed by gas classification to alter the particle size distribution. The metal powder is mixed with thermoplastic binders to produce a homogeneous feedstock; with approximately 60 volume % metal powder and 40 volume % binders. Then, the feedstock is placed into an injection molder and molded to form a net shape green part.

Injection molding occurs at relatively low temperatures and pressures in conventional plastic injection molding machines. The molds are similar to those used for plastic injection molding including slides and multi-cavity configurations. After injection molding, two thermal processes occur. First, the binder is removed from the green part via an evaporative process called "debinding." Second, after debinding the part is sintered to form a high-density metal part. Sintering occurs at high temperatures, up to 2300°F

(1260°C), near the melting point of the metal; under a dry H_2 atmosphere or inert gas atmosphere.

During sintering, the part will shrink isotropically to form a dense shape. Since, the complex shape of the molded part is retained through the process, close tolerances in the as-sintered part can be achieved. Scrap is eliminated or significantly reduced since machining of the part after sintering is usually not necessary.

As a continuation of the described process of this invention, magnesium and titanium face and sole plates cast with the above squeeze-casting process can be further heat treated to harden them and prepare them to be attached to the club head. This hardening can be carried out without affecting the tensile strength of the club head bodies cast by this method, which are cast from different alloys and not heat treated.

This invention uses the above process, including several steps standard in squeeze--casting and MIM-casting, and applies it to